

Remarks

The Examiner has rejected Claims 45 and 47 based on the lack of antecedent basis for the phrase "said liquid crystal tunable filter." In response, the Applicants have modified Claim 45 to remove the need for the antecedent basis for the specified phrase. As a result, both Claims 45 and 47 should now be in proper form.

The Examiner has rejected all pending claims of the application with the exception of claims 3 and 29 under 35 U.S.C. § 103(a) as being unpatentable over various combinations of Feld, et al. (PCT WO95/11624) in view of Wach, et al. (U.S. Patent 6,222,970) and further in view of Ono, et al. (U.S. Patent 5,394,499) and other prior art. The Applicants argue below that the combination of Feld, Wach and Ono is inappropriate in light of the teachings of those references and the objectives of the present invention. Further, the Applicants believe that the Examiner has made several inaccurate interpretations of what is disclosed by Wach relative to the Applicant's invention.

In particular, the Examiner states, on page 3 and continuing on to page 4 of the office action, that Wach teaches a "laser rejection filter positioned between said sample and said coherent fiber bundle for transmitting wavelengths of light other than said specific laser excitation wavelength, as described in column 53, lines 15-24. The Applicants respectfully submit that Wach do not teach a laser rejection filter positioned between the sample and the coherent fiber bundle, but instead teaches a configuration in which the filter (referenced as number 6360 in Figure 63) is located between two fibers significantly away from the distal end of the fiberscope near the sample (at least one inch away from the end of the fiber bundle as recited in Column 34, lines 52-54) in which the fibers are aligned by needle tubing 6350 (See Column 52, lines 59-62) and where an index matching gel is applied to the mating surfaces (See Column 53, lines 23-24). Thus, Wach does not teach a configuration wherein the filter 6360 is

located between the coherent fiber bundle and the sample as recited in Claims 2, 28 and 42 of the present application. The design of the present application is not taught or inferred by Wach and is significantly simpler than the configuration in Wach as shown in Figure 1 of the present invention. Most significantly, the present invention has incident and collection fiber bundles terminating at the filter and does not require matching or adjoining fibers as taught by Wach. This arrangement significantly simplifies the construction and reduces the cost of the device of the present invention.

The Examiner further states at the top of page 4 that Wach discloses "a spatial filter positioned between sample and coherent fiber bundle as described in Column 34, lines 58-61 and Column 64, lines 25-32 (of Wach)." The Applicants respectfully submit that this statement is also inaccurate. Wach teaches, at Column 34, line 59, that "unwanted wavelengths are angularly displaced. In so doing in light of undesirable wavelengths can be directed outside the fiber's internal reflection limited." The spatial filter of the present invention does not direct light outside of the fiber's internal reflection limit. Instead, the light is spatially blocked from even entering the fiber. Furthermore, in Column 64, line 26, Wach also describes the filter as such: "the filter can be applied at an angle of approximately 45° so that the subsequent reflected and transmitted light can be transmitted to locations in an optical assembly for subsequent processing. In the context of internal reflection, this then allows light at larger maximum angle to not be transmitted." The present invention has no such angle filters. Figure 1 shows the design when this filtering does not require the angular inclination described by Wach. Angularly inclined filters as described by Wach have an asymmetry in the transmission and filtering of light that is detrimental in terms of allowing uniform transmission of the light collected by the fiber from the field of view on the sample. Such angled filters are clearly detrimental for the purposes of spectral imaging in the present invention. In Wach's application there is no consideration for preserving the spatial information coming off of the sample during spectroscopy as we do in

obtaining spectroscopic images of the sample. Thus, Wach's teaching of angularly inclined filters teaches away from the goals of imaging of sample spectra in the present invention and argues against the combination of Wach with Feld and Ono. As a result, the Applicants have amended independent Claims 2, 22, 28 and 48 to specify that the spatial filter be positioned square to the axis of the coherent fiber bundle. This eliminates any asymmetry in the transmission and filtering of light which may be caused by angled filters. The Applicants therefore submit that the specific arrangement claimed in the present invention, having a combination of a band pass and notch filters with an aperture (spatial filter) all arranged in a particular sequence and orientation is not suggested or anticipated by Wach.

Further, with respect to Ono's teaching of a spatial filter in view of Wach and Feld, the Applicants strongly feel that it is inappropriate to consider Ono's teachings as applicable to the present invention and in combination with Wach and Feld. First, Ono's fiber bundle and teaching refer to a particular type of fiber bundle in which the small diameter of the fibers, together with the cladding used, dramatically changes the nature of the light propagation in these fibers. Ono states, at Column 3, line 139: "for a so called optical fiber whose core diameter is very small, that is, of the order of a few times the wavelength of propagating light...it is necessary to treat it from the standpoint of wave optics."

Specifically, Ono's fibers exhibit wave like interference effects that create striking intensity variations and nodes in the light distribution emerging from each fiber. Ono states, at Column 4, line 28, "it is to be noted that the light actually propagating in the optical fiber is composed of light of various modes. The ratio of these modes varies with a varying F number of the object lens or a varying numerical aperture."

Thus, changes in the aperture effect the specific modes and how they superimpose to form an image. The effects are not applicable to fibers such as the ones used in the present invention, that do not have such optical modes.

Ono further states at Column 5, line 4: "The image does not become brighter even if the numerical aperture on the exit side of the objective is made greater." Thus, the behavior of the fibers of Ono do not follow conventional optical thinking and conventional opto-geometrical approaches do not apply.

Coupling and cross talk coupling between fibers is another complication not arising in conventional fiber bundles which Ono also extensively considers in Column 7, line 30, through Column 12, line 21, which further complicate the properties and behavior of Ono's device.

The fiber bundle of the present invention is a conventional fiber bundle which functions in the classical opto-geometric regimen. In addition, in the present application, the Applicants state that the cladding in the fiber bundle is removed (differentiating it from Ono's fiber bundle) to enable better high temperature properties (See page 6, lines 28-32 of the present application). Thus, the nature and behavior of the fiber bundle of the present invention will differ significantly from Ono's fiber bundle.

Thus, the teachings of where and how to use an aperture and a lens as discussed by Ono are not applicable to the conventional coherent fiber bundle as used in the present invention. For Raman imaging, the present invention also requires a more complex optical system composed of a filter lens and an aperture between the optical fiber and the sample. The design of the present invention reduces the light appearing at a range of wavelengths required for Raman spectral images. Ono does not consider, nor teach, the case of imaging light over a range of wavelengths.

Because of the very different operating regime of Ono's fiberscope, together with the differences in optical elements and their functions, the Applicant's respectfully submit that it is not obvious that such an aperture and where it should be placed is relevant to improve Raman images.

As a result, the Applicants believe that it is inappropriate to combine Ono with Wach and Feld to reject the Claims 2, 28 and 42 under 35 U.S.C. § 103(a) and the Applicants respectfully request reconsideration of those claims in light of these comments.

The remainder of the claims in the application are dependent upon the three rejected independent claims, which the Applicants believe should not be rejected in light of the combination of Feld, Walk and Ono, as it is inappropriate to combine these references to teach the present invention.

The Examiner states on page 9 of the Office Action that Claims 3 and 29 are objected to as being dependent upon the rejected base claims but would be allowable if rewritten in independent form, including all of the limitations of the base claim and any intervening claims. The Applicants appreciate the Examiner's notification that these claims contain allowable subject matter. The Applicants do not wish to modify the claims at this time to convert them to independent claims, pending the Examiner's reconsideration of the claims as they currently stand in light of the above remarks. However, the Applicants reserve the right to do so in the future.

Conclusion

The Applicants have provided reasoned arguments as to why is inappropriate to combine the cited references to claim that the present invention is obvious. In addition, the Applicants have shown that the Examiner has made several inaccurate statements regarding what is disclosed by the Wach reference, and why what Wach discloses is different from the elements of the present invention. In addition, the Applicants have modified the independent claims of the application to specify that the spatial filter be arranged square to the axis of the coherent fiber bundle, to eliminate undesirable effects which may be caused by the angularly inclined filters taught by Wach. As a result, the Applicants believe that the present claims, as they stand, are patentably distinct from the combination of the cited references, and respectfully requests reconsideration of those claims in light of the remarks herein.

Respectfully Submitted,



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